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13. ABSTRACT *(Maximum 200 words)*

THIS IS A PROGRESS REPORT ON AEROJET'S STUDIES OF EXPERIMENTS CURRENTLY UNDERWAY (E.G., PLANT GROWTH & DIMP & DCPD LYSIMETER TESTS). FIVE TYPES OF SOIL INCLUDING CHINO, BRAWLEY, VENTURA, FULLERTON & WALNUT HAVE BEEN SUBJECTED TO TWO TYPES OF LYSIMETER TESTING. PRELIMINARY DATA FROM PLANTS GROWN IN THE TASK III PART 1 SOIL CULTURE EXPERIMENTS IS AVAILABLE.

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DETERMINATION OF DECONTAMINATION CRITERIA

DIMP AND DCPD (U)

Rocky Mountain Arsenal
Information Center
Commerce City, Colorado

Report No. 1953-01(14)MP

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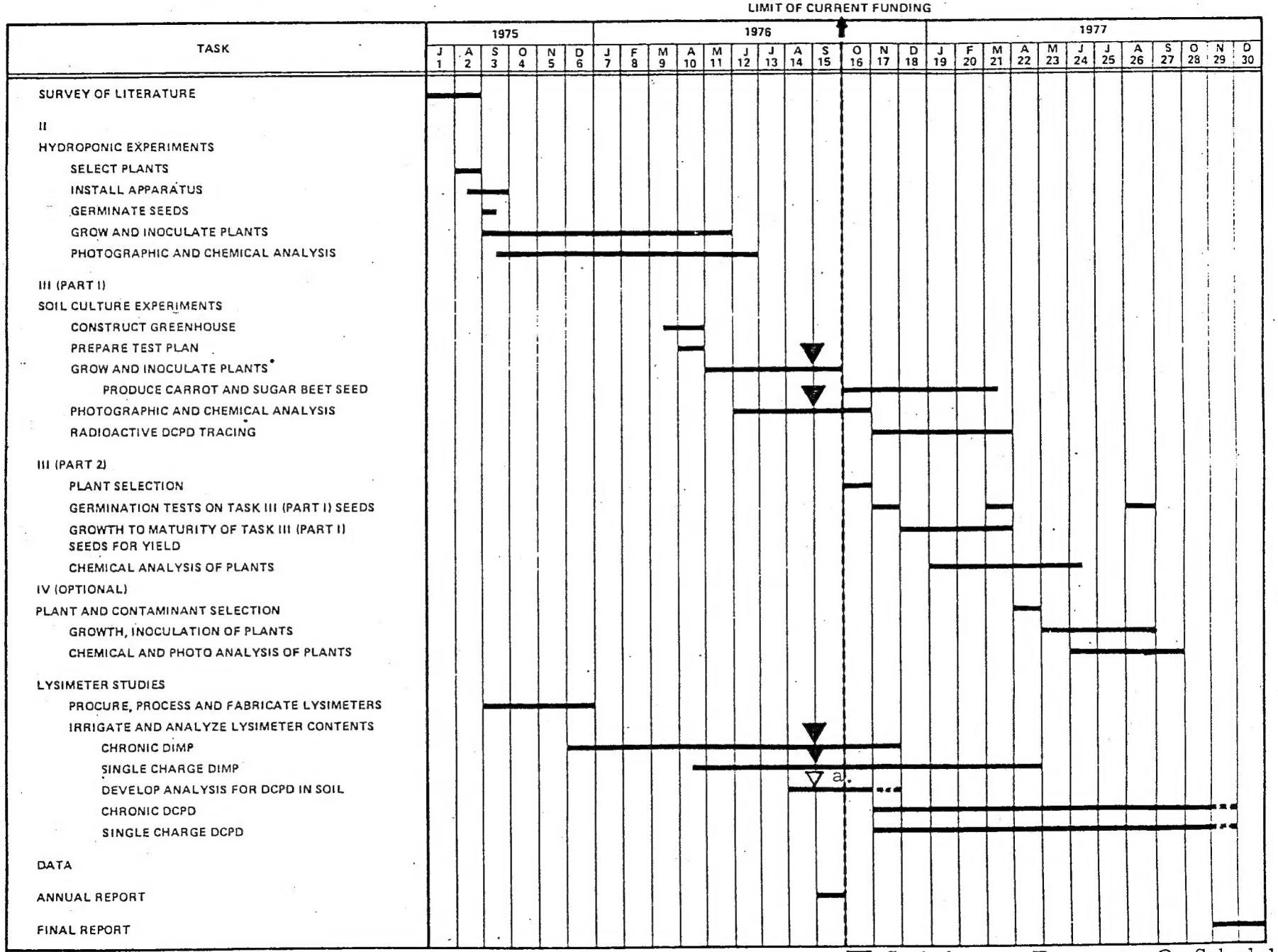
DETERMINATION OF DECONTAMINATION CRITERIA DIMP AND DCPD RESEARCH TASK SCHEDULE



*POSSIBLE SLIPPAGE POINT. ADJUSTMENT OF CONTAMINANT AT THIS POINT SHIFTS ALL FOLLOWING PLANT WORK TO THE RIGHT.

▼ Satisfactory Progress-On Schedule

▽ Slippage of Schedule

a. Est. 1 month delay in DCPD soil extraction development.

Progress on items proposed for action during August, 1976 is discussed in the following paragraphs.

FULL SCALE LYSIMETER TESTS

Five types of soil, including

Chino	-	Sandy clay loam
Brawley	-	Silty clay
Ventura	-	Clay loam
Fullerton	-	Sandy loam
Walnut	-	Clay loam

have been subjected to two types of lysimeter testing. The first type consists of irrigating an epoxy coated, steel lysimeter containing approximately a five foot depth of the sample soil with two inches (12, 887 ml) of distilled water containing 20 parts per million (ppm) diisopropyl methyl phosphonate (DIMP) at regular intervals. These tests were designated as Group 1.

The frequency of irrigation was once each week to start but after several months was reduced to once each two weeks due to the slowing of the overall drainage rate of the lysimeters. At specified intervals the water in the lysimeters was sampled by removing a small portion through an imbedded porous ceramic tensiometer tube at each of five levels in the lysimeter soil. A sixth sample consists of the drain water at the bottom of the lysimeter.

Soil samples were taken at regular intervals also by means of a core sampler. These soil and water samples were analyzed by gas-liquid chromatography for DIMP content. Results of the most recent soil sample analyses are shown in Table 1 and for the most recent water analyses, see Table 2.

A similar experimental set up was used with the second type of lysimeter tests in which the top one foot layer of soil in each lysimeter was intimately blended with DIMP to result in a concentration of 20 ppm DIMP in the soil. These lysimeters were subjected to irrigation with distilled water at the rate of 12, 887 ml every two weeks. This set of experiments is designated as Group 2.

Table 1

DIMP Content of Soil Samples Group I (247 days)

Depth	Ventura	Chino	Fullerton	Walnut	Brawley
0 (surface)	88.7	20.7	34.0	35.0	26.1
0 - 6"	8.3	10.1	11.8	17.1	7.8
6 - 12"	8.6	6.8	15.0	11.8	7.0
12 - 18"	4.6	8.9	10.0	11.4	6.4
18 - 24"	4.3	5.6	14.1	9.7	2.7
24 - 30"	5.6	5.8	11.4	11.7	7.2
30 - 36"	2.0	4.8	15.0	10.0	11.8
36 - 42"	3.5	6.2	12.1	9.8	7.1
42 - 48"	3.3	4.5	9.6	14.4	5.9
48 - 54"	3.4	6.0	8.9	15.0	7.3
54 - 60"	4.4	8.4	10.1	8.2	7.9

Table 2

DIMP Content of Tensiometer Water Samples
(Group 1 East)

Depth	Ventura	Chino	Fullerton	Walnut	Brawley
		(ppm @ 240 days)			
6"	**	19.44	19.30	13.71	**
18"	4.34	14.63	17.69	15.83	15.72
30"	4.10	14.43	14.25	15.57	16.09
42"	7.06	21.10	**	**	12.54
54"	8.47	10.65	9.15	11.70	9.23
60"	14.06	11.54	7.67	11.34	12.03
		(ppm @ 254 days)			
6"	9.31	16.34	45.60	37.22	23.40
18"	6.83	18.16	31.85	22.22	20.53
30"	11.11	17.97	37.96	39.51	14.75
42"	11.23	16.75	19.75	23.04	17.01
54"	16.00	18.14	17.28	49.79	16.55
60"	23.37	12.34	10.96	33.90	17.95

** No Sample

The most recent analyses of soil from Group 2 are shown in Table 3 and for water, Table 4.

The Group 1 data in general indicates a decrease in contaminant concentration with depth in the soil. This is generally true for the water samples as well, with the exception of the Ventura sample.

The Group 2 data indicates that the DIMP has been moving downward in the soil and at the 112 day sample has reached the lowest soil level. Significant quantities of the contaminant have not yet appeared at the lowest level of water sample.

Figure 1a through 1e plots the concentration levels of DIMP in the Group 1 tensiometer samples for 240 and 254 days. As noted previously the general trend is for the concentration to increase with time and with proximity to the soil surface.

Generally the amount of DIMP present increases with time. The DIMP concentrations in the individual tensiometer samples, especially in the case of the Walnut samples, are somewhat scattered. This can be ascribed possibly to the minimal quantity of samples which sometimes is obtained. This could be greatly affected by residues from previous samples in the tensiometer tubing. The sixty inch sample, which is essentially at the drain, does not have this drawback. This sample usually consists of several liters of liquid which would not be significantly affected by such residues. A plot of the DIMP content of the sixty inch samples is probably a more effective indicator of the contaminant breakthrough. These plots are shown in Figures 2a through 2e for the five Group 1 lysimeters.

The amount of DIMP in the drainage water should be added to that found in the soil for proper material balance. Using the analyses of the drain samples as a basis the drain recovery of DIMP shown in Table 5 can be calculated.

Table 3

DIMP Content of Soil Samples Group 2 (112 days)

Depth	Ventura	Chino	Fullerton	Walnut	Brawley
0 (surface)	*	*	*	*	*
0 - 6"	*	*	*	*	*
6 - 12"	*	*	*	*	*
12 - 18"	*	2.7	*	*	*
18 - 24"	6.0	6.9	14.7	1.9	11.5
24 - 30"	19.8	14.0	14.7	7.1	19.2
30 - 36"	13.4	21.6	8.2	14.3	6.6
36 - 42"	6.0	16.9	8.3	22.1	2.1
42 - 48"	5.4	6.4	15.0	2.6	0.5
48 - 54"	1.9	2.4	14.1	2.0	1.1
54 - 60"	1.6	4.1	7.0	0.4	0.8

* <0.1 ppm

Table 4

DIMP Content of Tensiometer Water Samples (105 days)
(Group 2 West)

Depth	Ventura	Chino	Fullerton	Walnut	Brawley
6"	*	*	6.4	*	*
18"	47.3	196.8	24.8	7.0	66.3
30"	20.2	45.8	45.9	261.8	2.5
42"	*	**	**	13.2	*
54"	*	*	*	6.4	*
60"	*	*	*	*	*

* <0.1 ppm

** No Sample

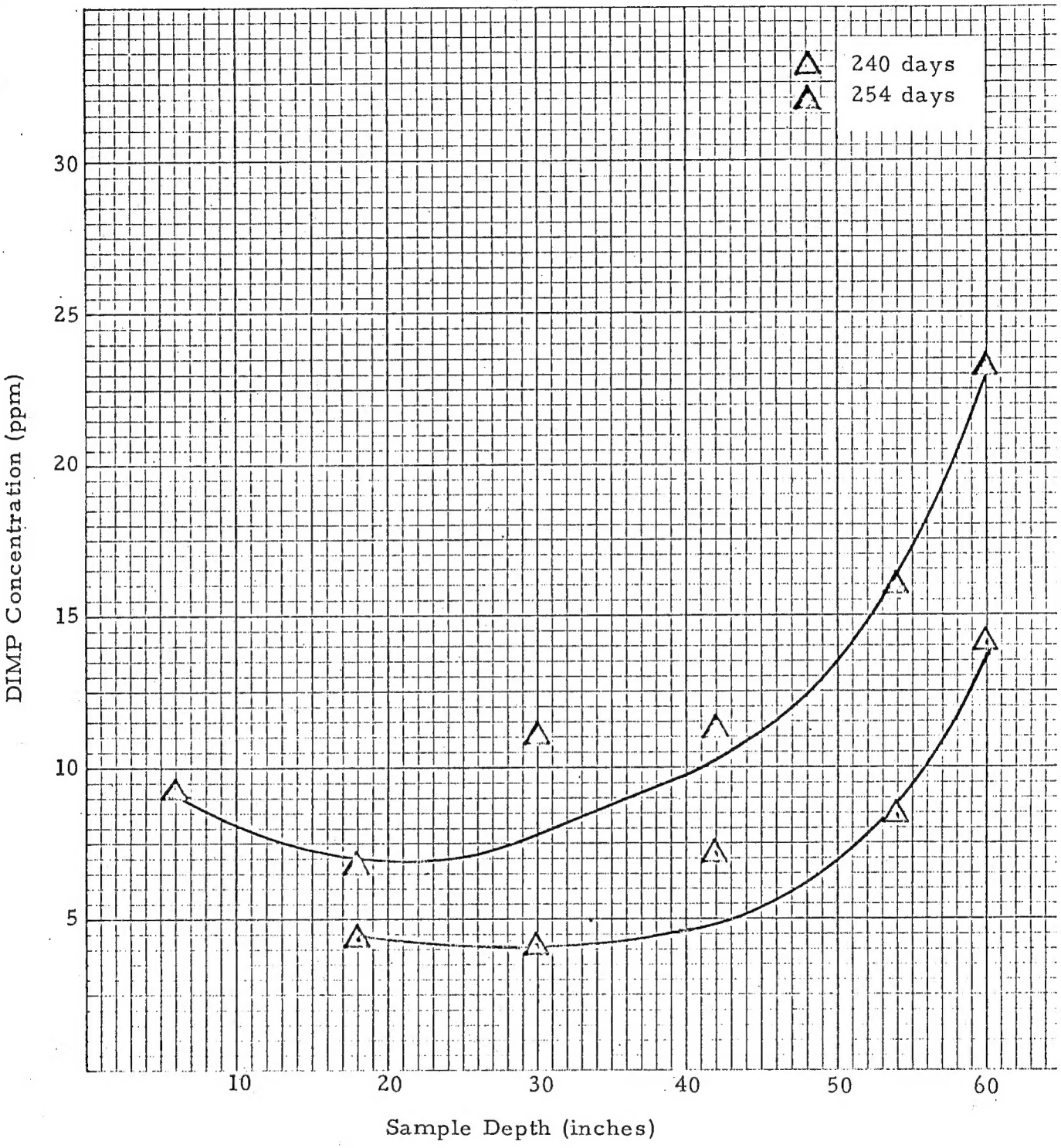


Figure 1a., DIMP Concentration vs. Sample Depth
Ventura Lysimeter, Group 1.

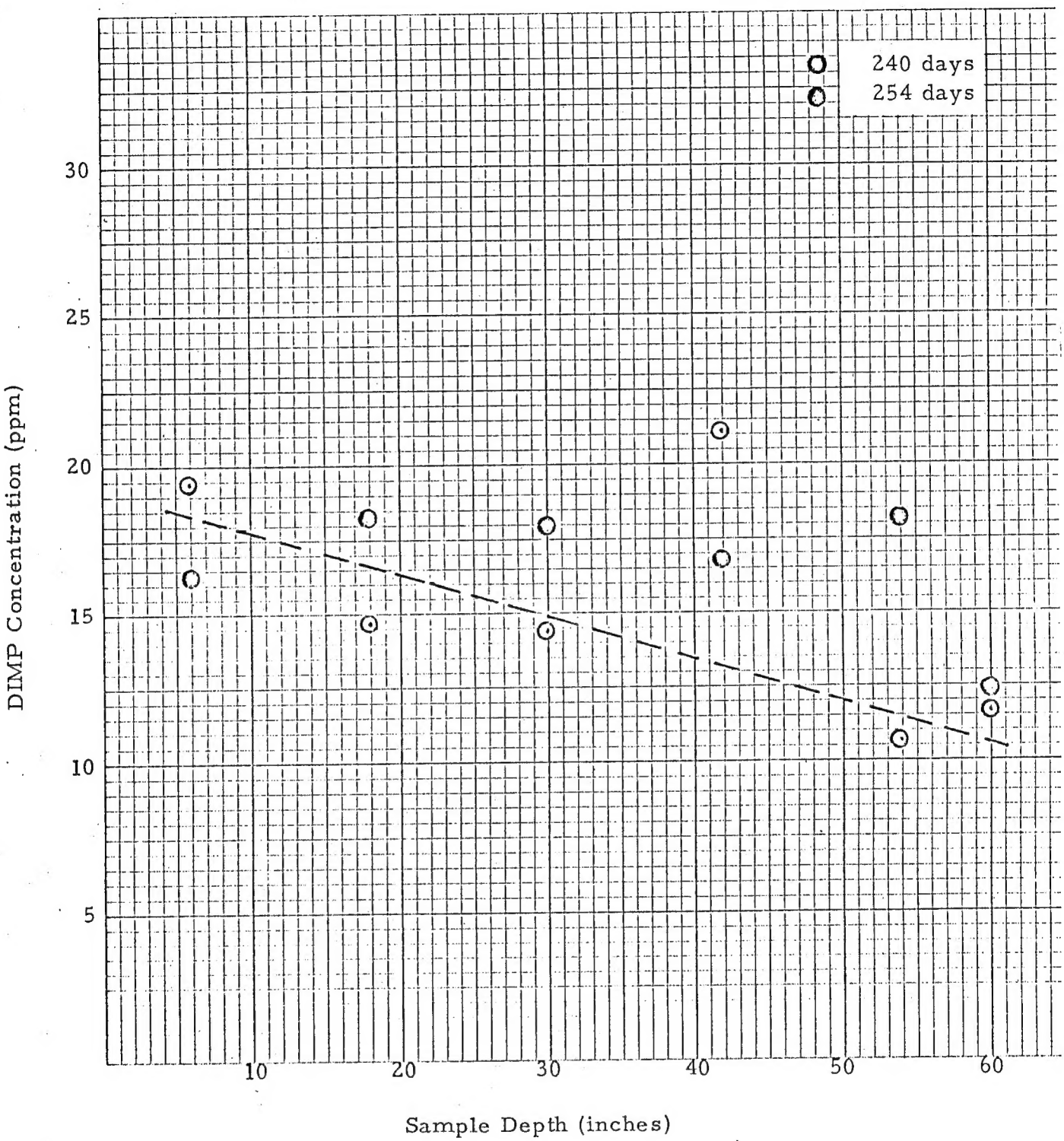


Figure 1b., DIMP Concentration vs. Sample Depth
Chino Lysimeter, Group 1.

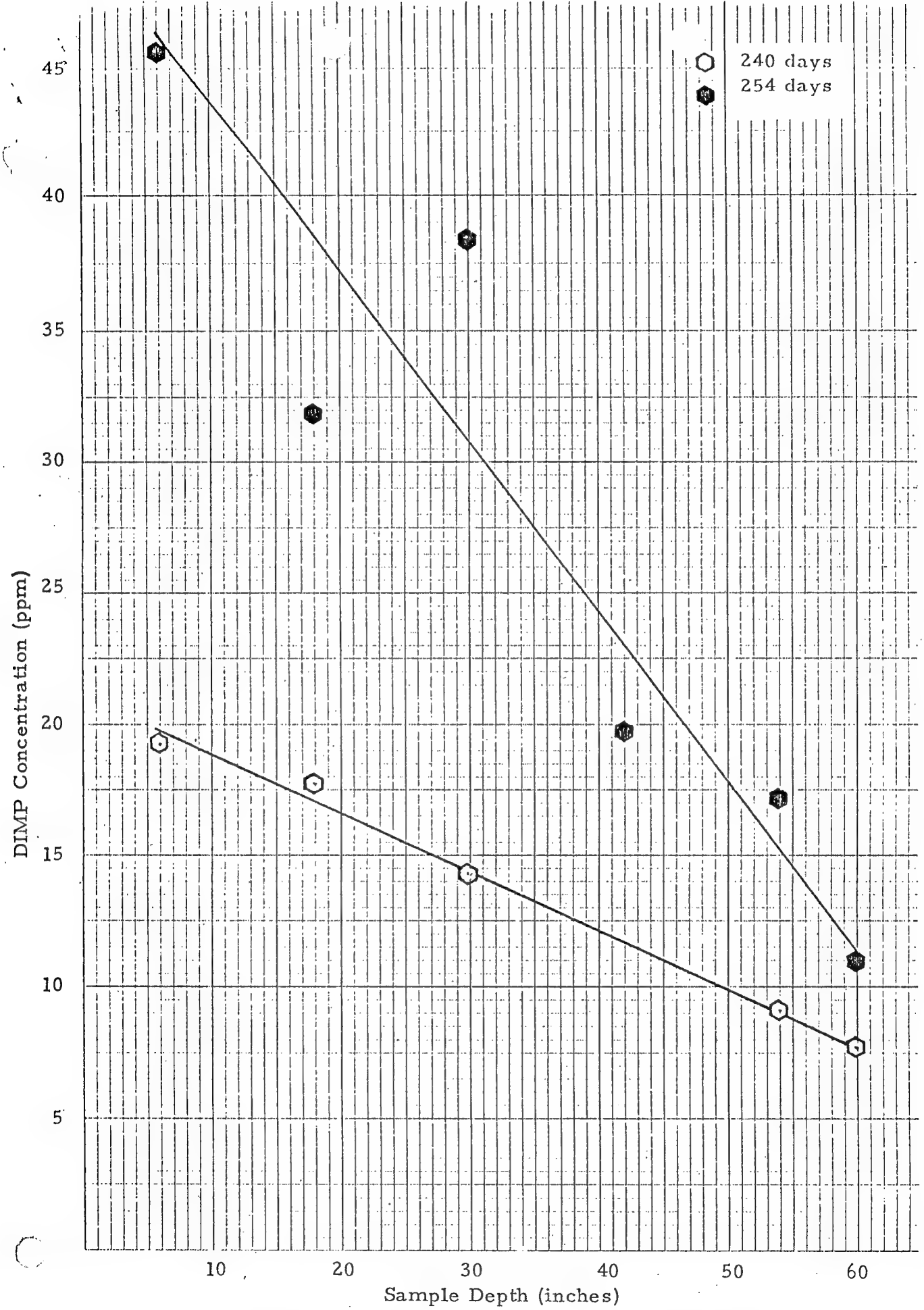


Figure 1c., DIMP Concentration vs. Sample Depth

Fullerton Lysimeter, Group 1.

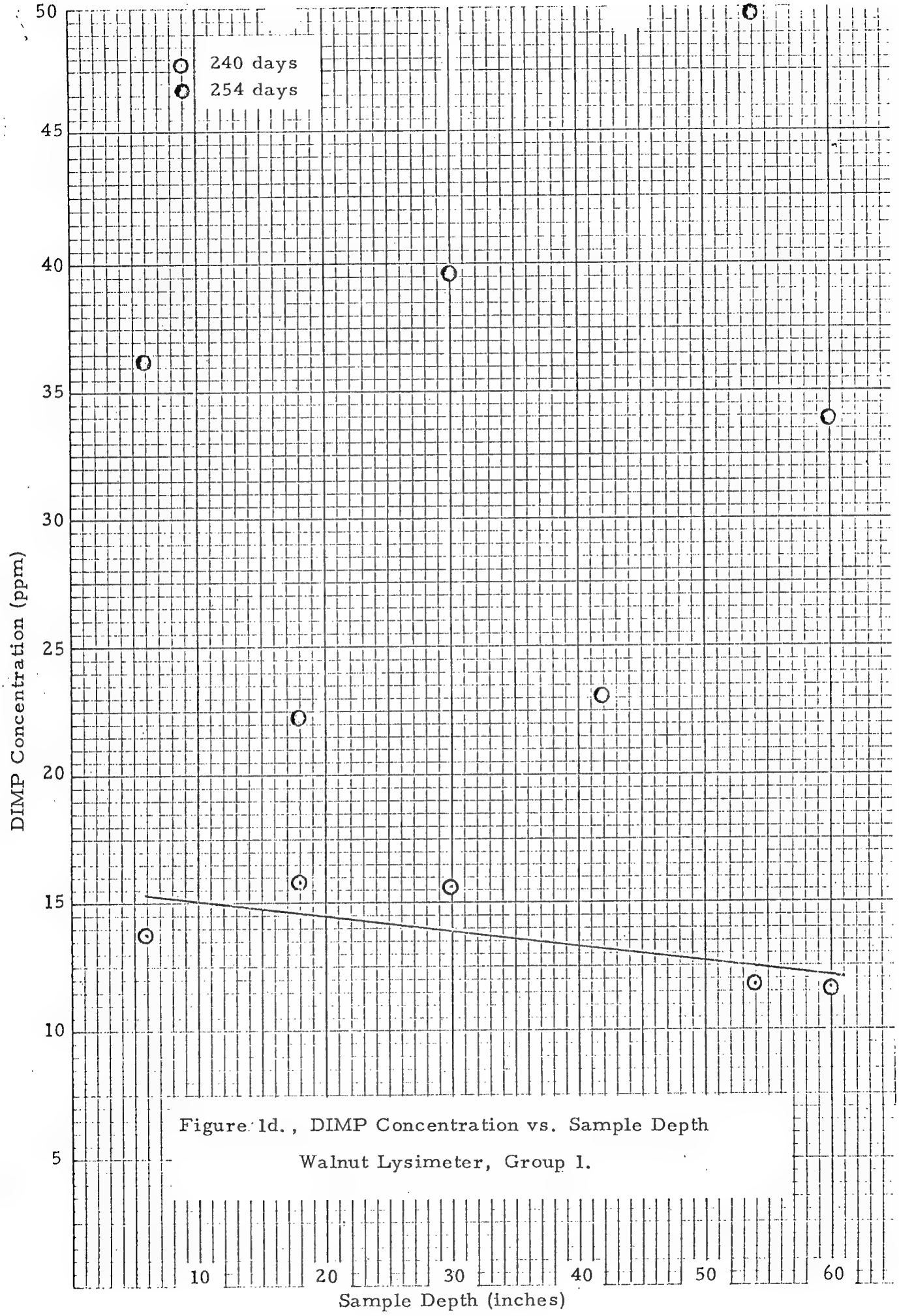


Figure 1d., DIMP Concentration vs. Sample Depth

Walnut Lysimeter, Group 1.

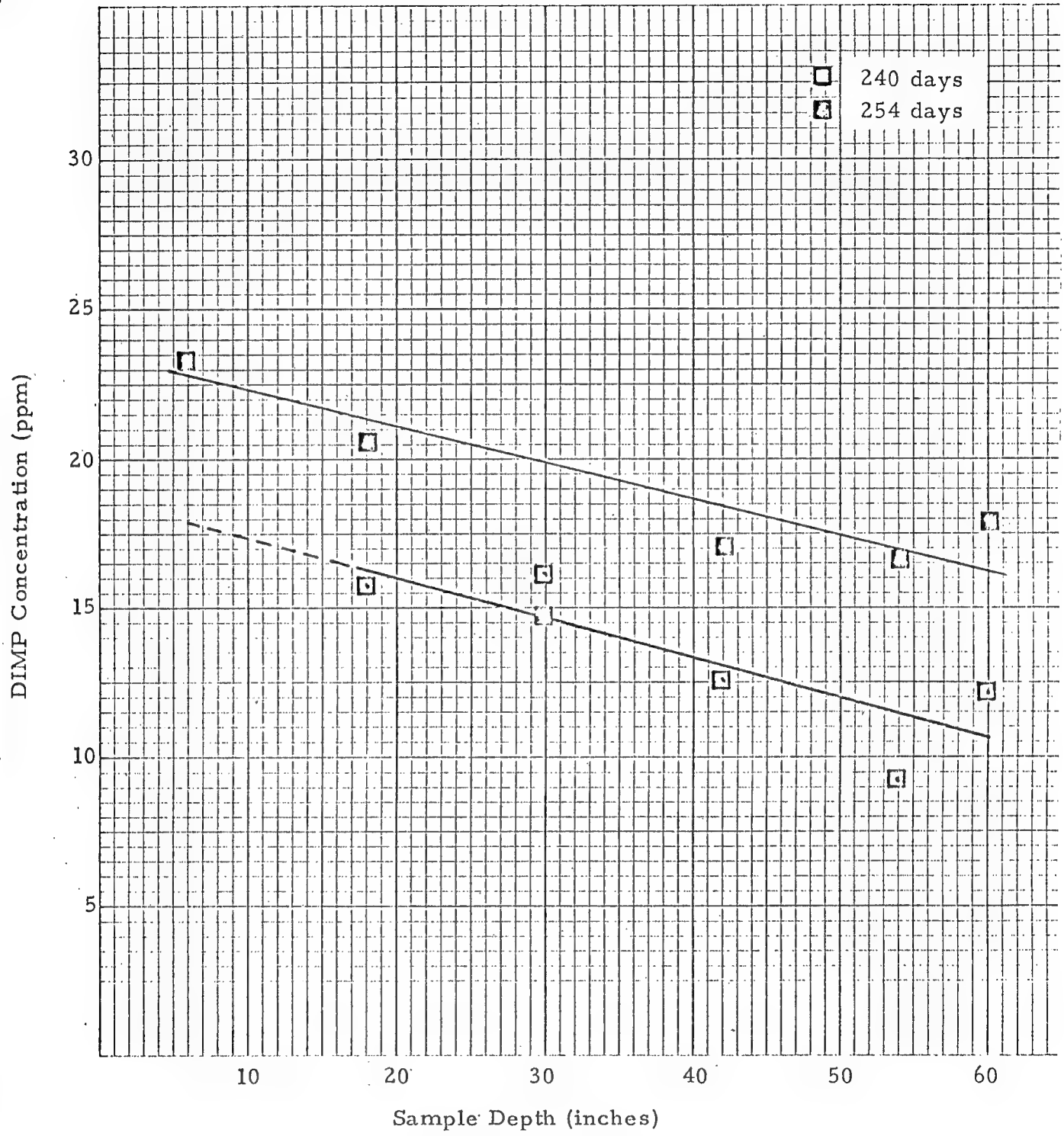


Figure 1e., DIMP Concentration vs. Sample Depth

Brawley Lysimeter, Group 1.

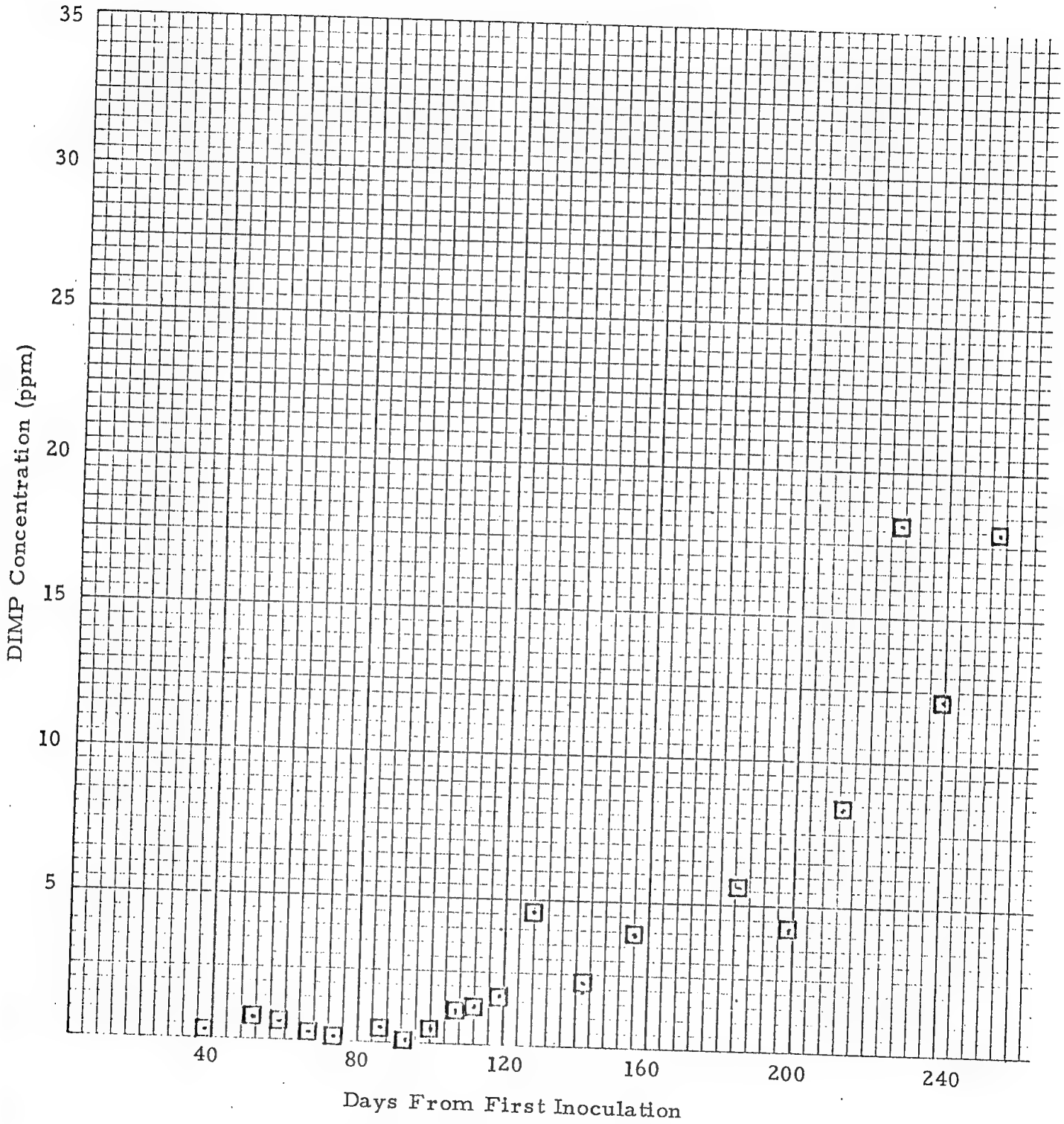


Figure 2a., Concentration of DIMP in 60 Inch Sample of Water

Brawley Lysimeter

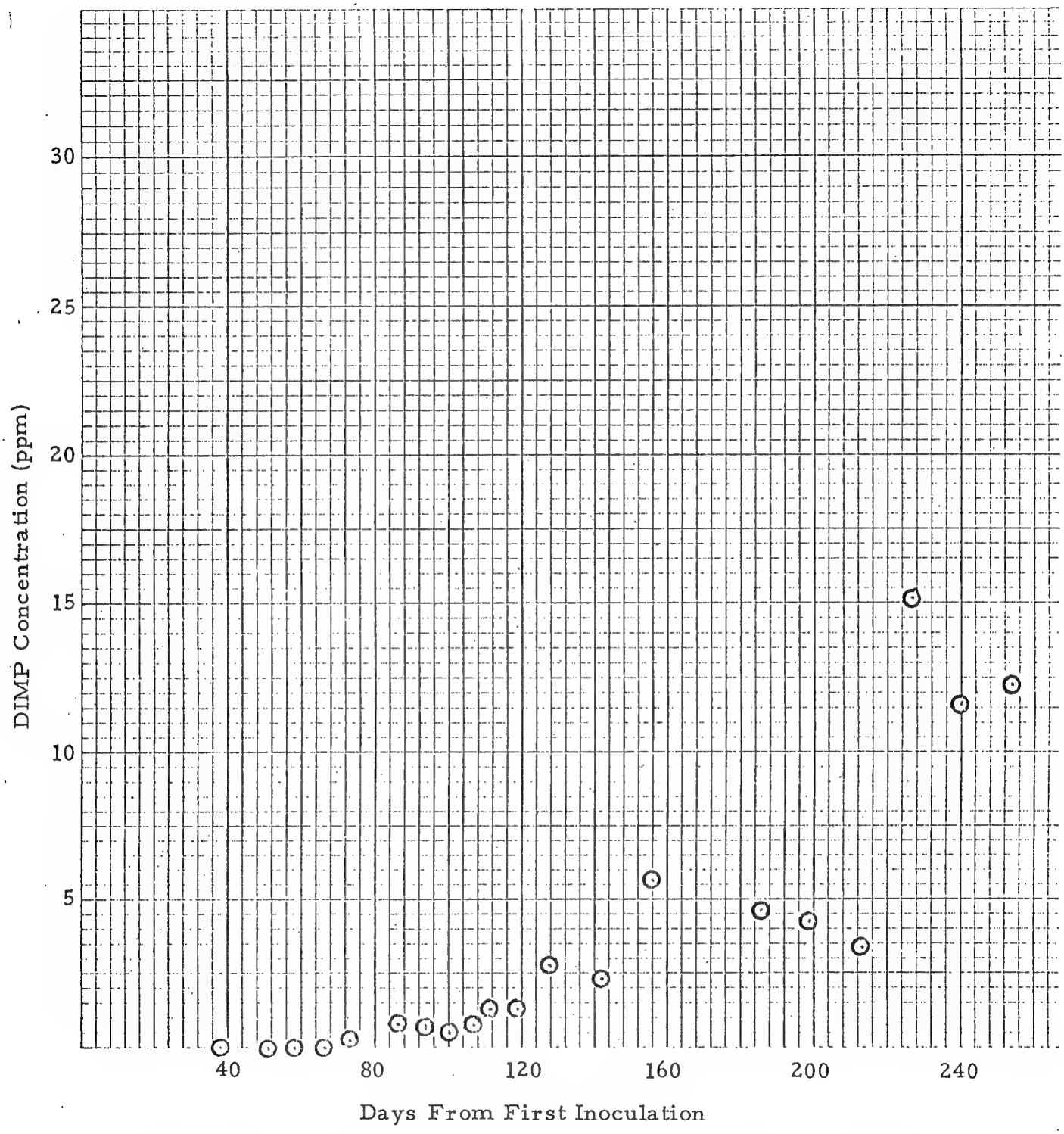


Figure 2b., Concentration of DIMP in 60 Inch Sample of Water
Chino Lysimeter

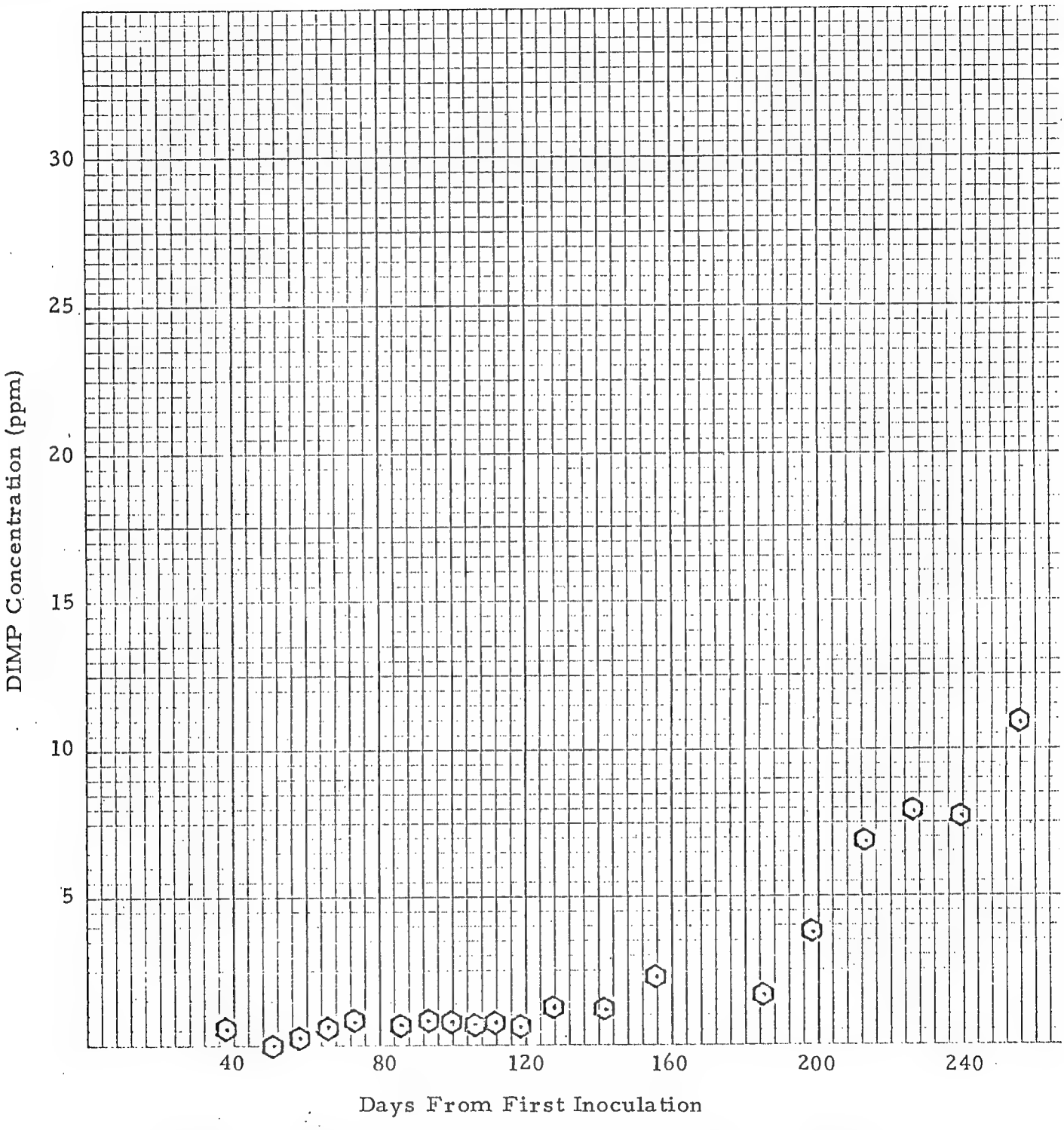


Figure 2c., Concentration of DIMP in 60 Inch Sample of Water

Fullerton Lysimeter

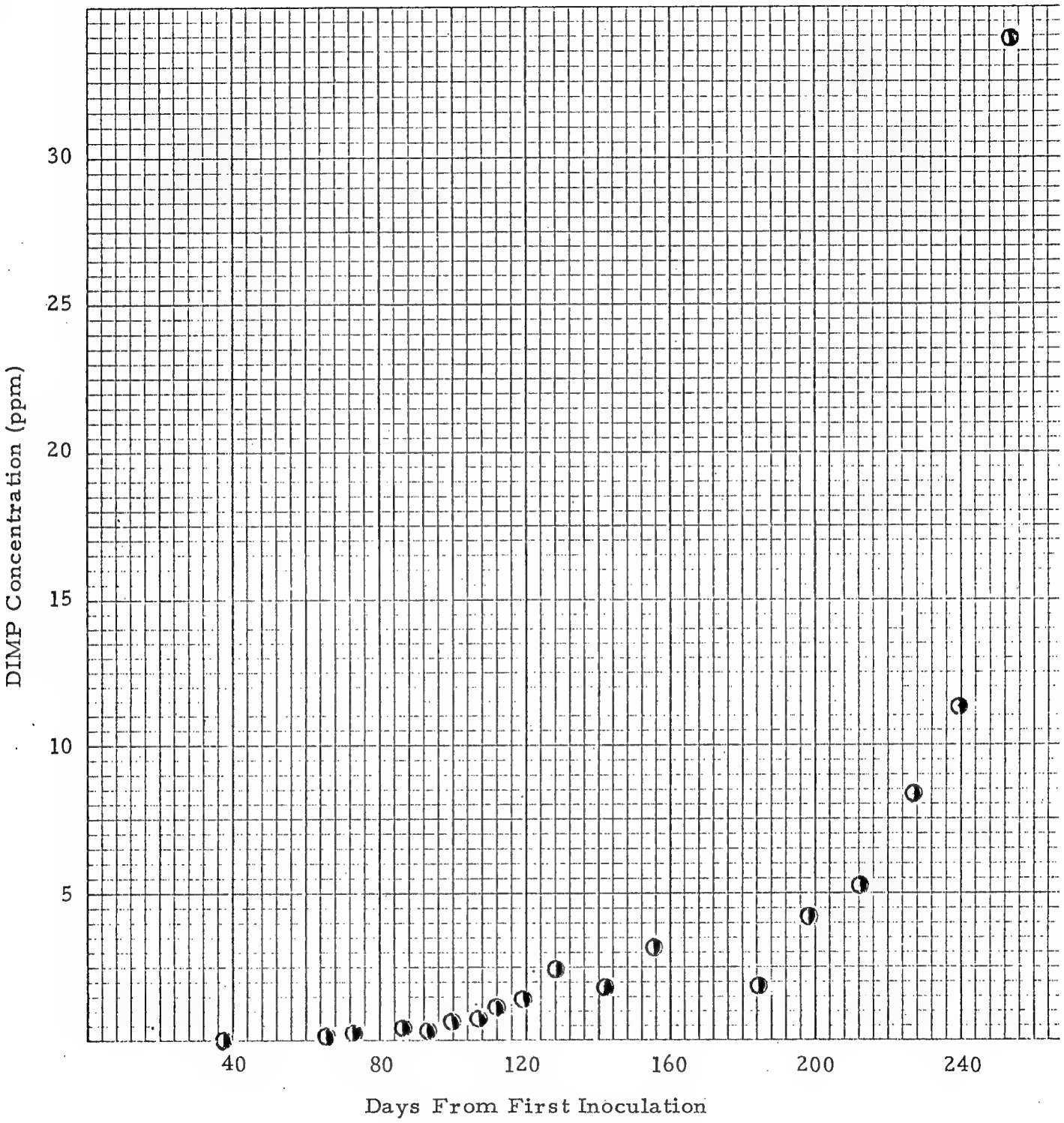


Figure 2d., Concentration of DIMP in 60 Inch Sample of Water Walnut Lysimeter

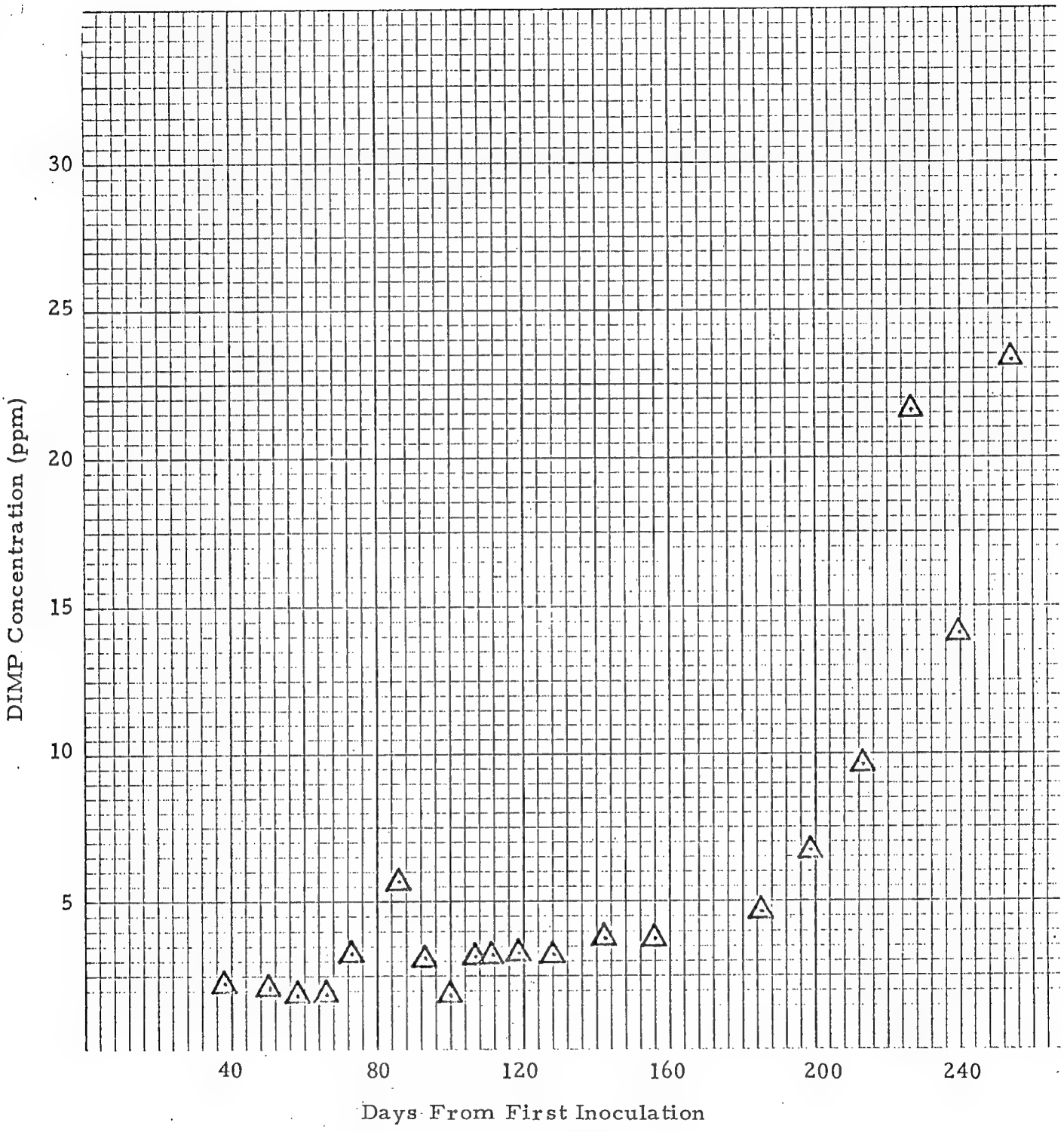


Figure 2e., Concentration of DIMP in 60 Inch Sample of Water

Ventura Lysimeter

Table 5

DIMP Content of Lysimeter Drainage Waters

Lysimeter Designation Group 1	Drain Volume (cc)	DIMP Concentration in Drain (ppm)	Weight of DIMP in Drain (g)
Chino	5120	12.34	0.063
Brawley	7870	17.95	0.141
Ventura	6490	23.37	0.152
Fullerton	3550	10.96	0.039
Walnut	6920	33.90	0.234

The amount of DIMP recovered in the soil samples for the various lysimeters is given in Table 6. These values are added to those from Table 5 to give figures for material balance in Table 6.

Table 7 lists the recoveries of DIMP in the Group 2 soils. No DIMP has yet appeared in the Group 2 drain water.

It would be expected that the bulk of the liquid added to the lysimeters would either be evaporated or drained through the apparatus. Determining the ratio of liquid drained (x) to liquid added (12, 887 ml) one establishes a number designated drainage efficiency. Figure 3 is a plot of these figures, currently labeled drainage ratio, versus time for the Group 1 lysimeters. Most of the points on the curve are averages of two successive data points. Figure 4 is a plot of the drainage ratios versus time for the Group 2 lysimeters. Figure 5 is a plot of the average drainage ratios for all members of each group of lysimeters versus time.

SOIL CULTURE EXPERIMENTS

Preliminary data from plants grown in the Task III part 1 soil culture experiments is available. These experiments consist of growing alfalfa, bean, carrot, sugar beet and wheat plants in 3 gallon pots in greenhouses and irrigating them from one week after breakthrough with either one, eight or twenty parts per million DIMP or DCPD in distilled water. The test plan for these experiments is discussed in Report No. 1953-01(11)MP.

Data on bioconcentration of DIMP in these plants after 65 days of irrigation are given in Tables 8, 9 and 10. This data is plotted in Figures 6, 7 and 8. These plots indicate that, in general, the soil culture results in the same trend as seen in the hydroponic tests, that is, that the leaves are significantly better concentrators for DIMP than the other plant parts.

Harvesting of the wheat and beans is complete and yield data on these experiments should be available next month.

Table 6

Material Balance - Lysimeters Group 1

247 Days (6.4425 g. DIMP Added)

Sample	Weight of DIMP In Drain H_2O (g)	Weight of DIMP In Soil (g)	Total Weight of DIMP Recovered (g)	Percent of DIMP Recovered
Chino	0.063	3.051	3.114	48.3
Brawley	0.141	2.605	2.746	42.6
Ventura	0.152	2.570	2.722	42.3
Fullerton	0.039	4.828	4.867	75.5
Walnut	0.234	3.485	3.719	57.7

Table 7

Material Balance - Lysimeters Group 2

Sample	Weight of DIMP In Soil (g)	Percent of DIMP Recovered
Chino	3.897	69.6*
Brawley	1.196	22.9
Ventura	1.560	29.2
Fullerton	1.950	32.6*
Walnut	3.651	69.9

* Complete set of samples for these lysimeters were not available for this time period.

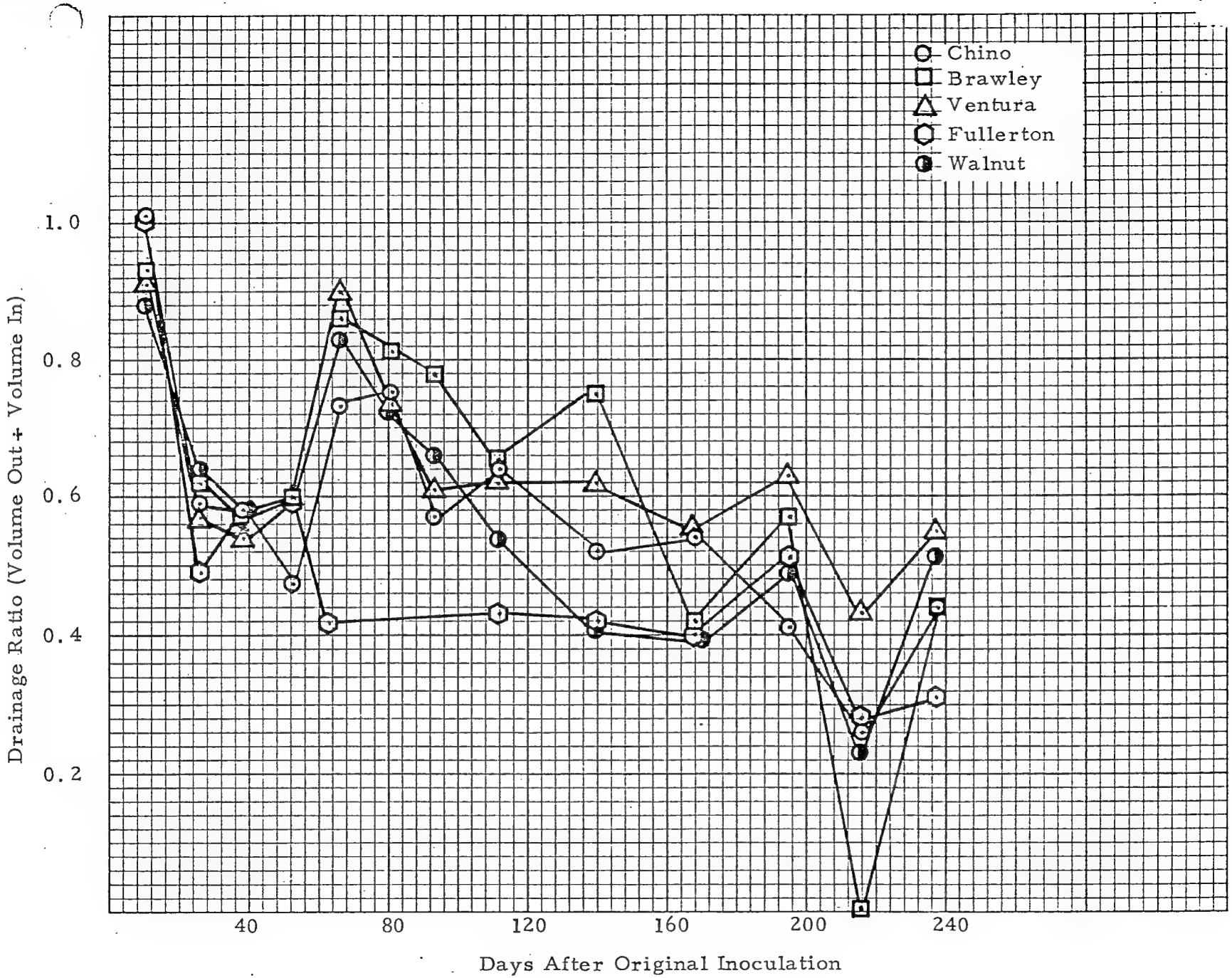


Figure 3., Drainage Ratios of Various Soils in Full Scale Lysimeter

Group 1

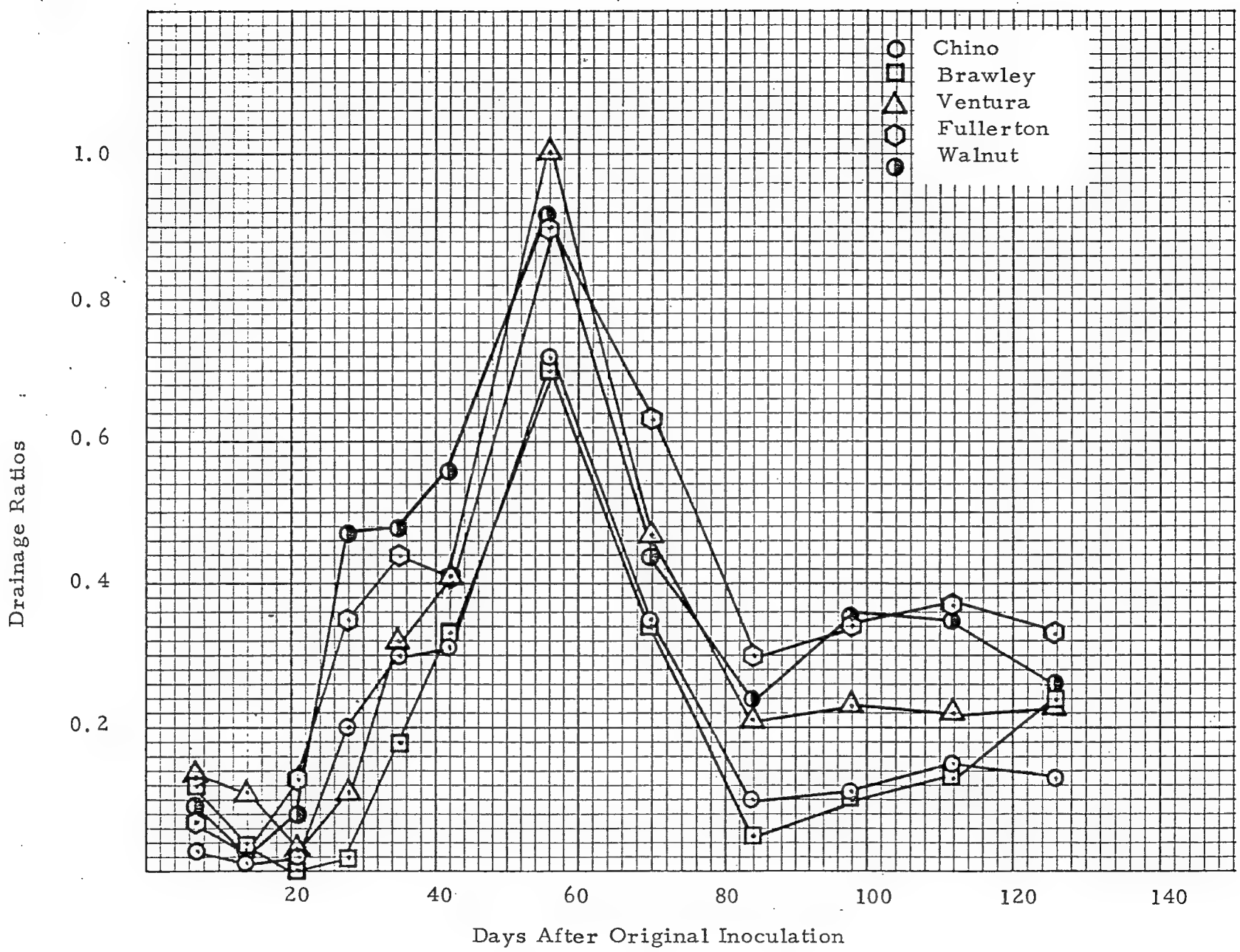


Figure 4., Drainage Ratios of Various Soils in Full Scale Lysimeter

Group 2

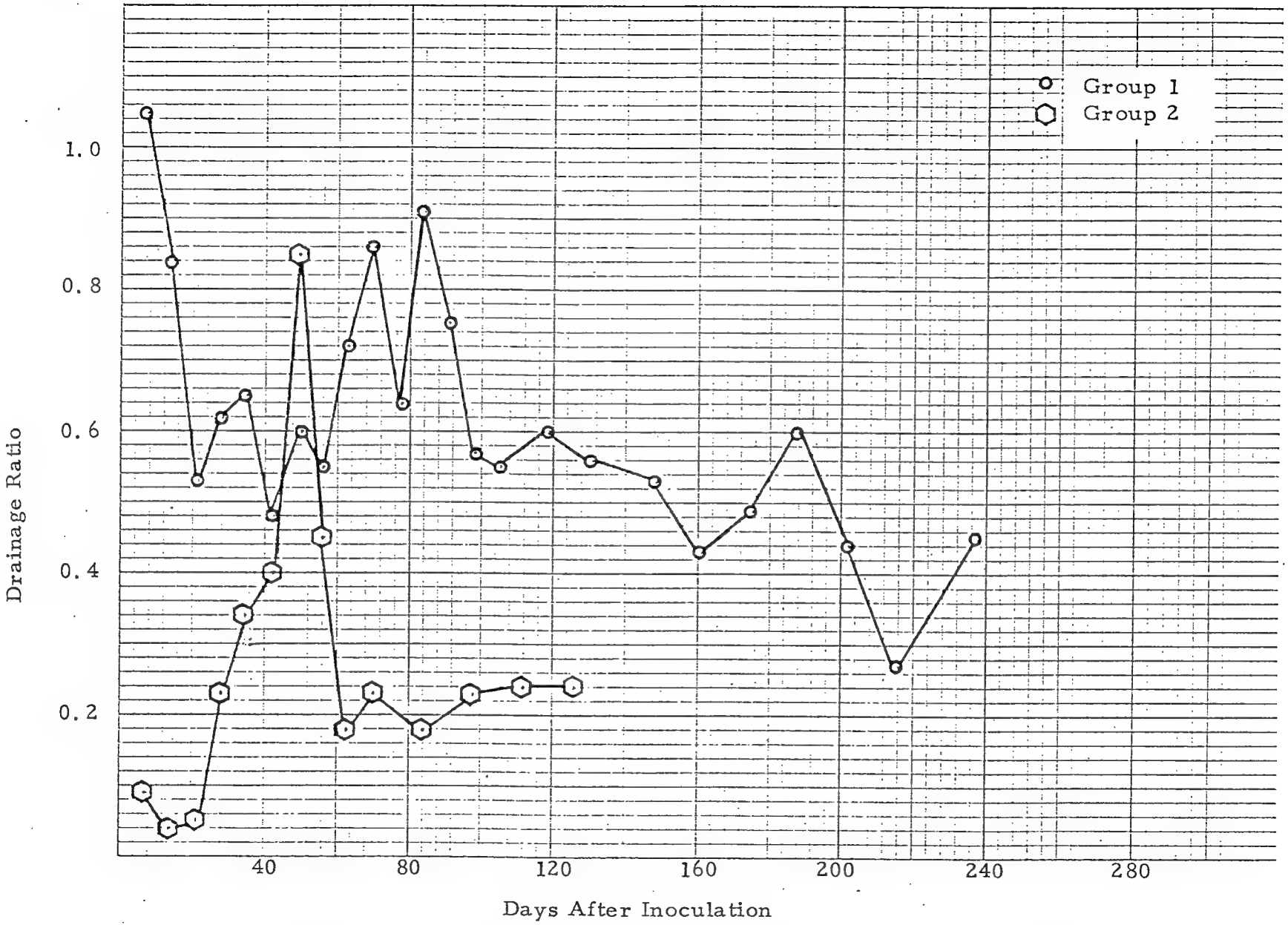


Figure 5., Drainage Ratios of Various Soils in Full Scale Lysimeter

Average of All Samples Within The Groups

Table 8

Bioconcentration of DIMP in Plant Parts

(65 Days From Initial Inoculation) (1 ppm)

Plant Part	Total DIMP Added to Container		DIMP Concentration in Fresh Tissue (ppm)	Bioconcentration Factor (x)
	Volume of Irrigation Solution (ml)	Weight of DIMP added (mg)		
Sugar Beet	15000	15		
Root			*	*
Stem			*	*
Leaf			*	*
Carrot	15000	15		
Root			2.1	2.1
Stem			3.0	3.0
Leaf			2.9	2.9
Bean	15000	15		
Root			8.5	8.5
Stem			0.9	0.9
Leaf			2.9	2.9
Wheat	15000	15		
Root			4.4	4.4
Stem			3.9	3.9
Leaf			*	*
Alfalfa	15000	15		
Root			1.3	1.3
Stem			5.1	5.1
Leaf			4.0	4.0

* < 0.1 ppm

Table 9

Bioconcentration of DIMP in Plant Parts

(65 Days From Initial Inoculation) (8 ppm)

Plant Part	Total DIMP Added to Container: Volume of Irrigation Solution (ml)	Total DIMP Added to Container: Weight of DIMP added (mg)	DIMP Concentration in Fresh Tissue (ppm)	Bioconcentration Factor (x)
Sugar Beet	15000	120		
Root			4.0	0.5
Stem			6.6	0.8
Leaf			10.6	1.3
Carrot	15000	120		
Root			7.2	0.9
Stem			10.2	1.3
Leaf			17.5	2.2
Bean	15000	120		
Root			46.1	5.8
Stem			28.8	3.6
Leaf			41.3	5.2
Wheat	15000	120		
Root			*	*
Stem			*	*
Leaf			85.5	10.7
Alfalfa	15000	120		
Root			4.9	0.6
Stem			9.6	1.2
Leaf			30.6	3.8

* <0.1 ppm

Table 10

Bioconcentration of DIMP in Plant Parts

(65 Days From Initial Inoculation) (20 ppm)

Plant Part	Total DIMP Added to Container: Volume of Irrigation Solution (ml)	Total DIMP Added to Container: Weight of DIMP added (mg)	DIMP Concentration in Fresh Tissue (ppm)	Bioconcentration Factor (x)
Sugar Beet	15000	300		
Root			17.8	0.9
Stem			26.9	1.3
Leaf			56.9	2.8
Carrot	15000	300		
Root			7.6	0.4
Stem			8.4	0.4
Leaf			111.4	5.6
Bean	15000	300		
Root			81.0	4.1
Stem			63.1	3.2
Leaf			120.5	6.0
Wheat	15000	300		
Root			22.0	1.1
Stem			9.6	0.5
Leaf			106.3	5.3
Alfalfa	15000	300		
Root			6.9	0.3
Stem			6.7	0.3
Leaf			43.6	2.2

* <0.1 ppm

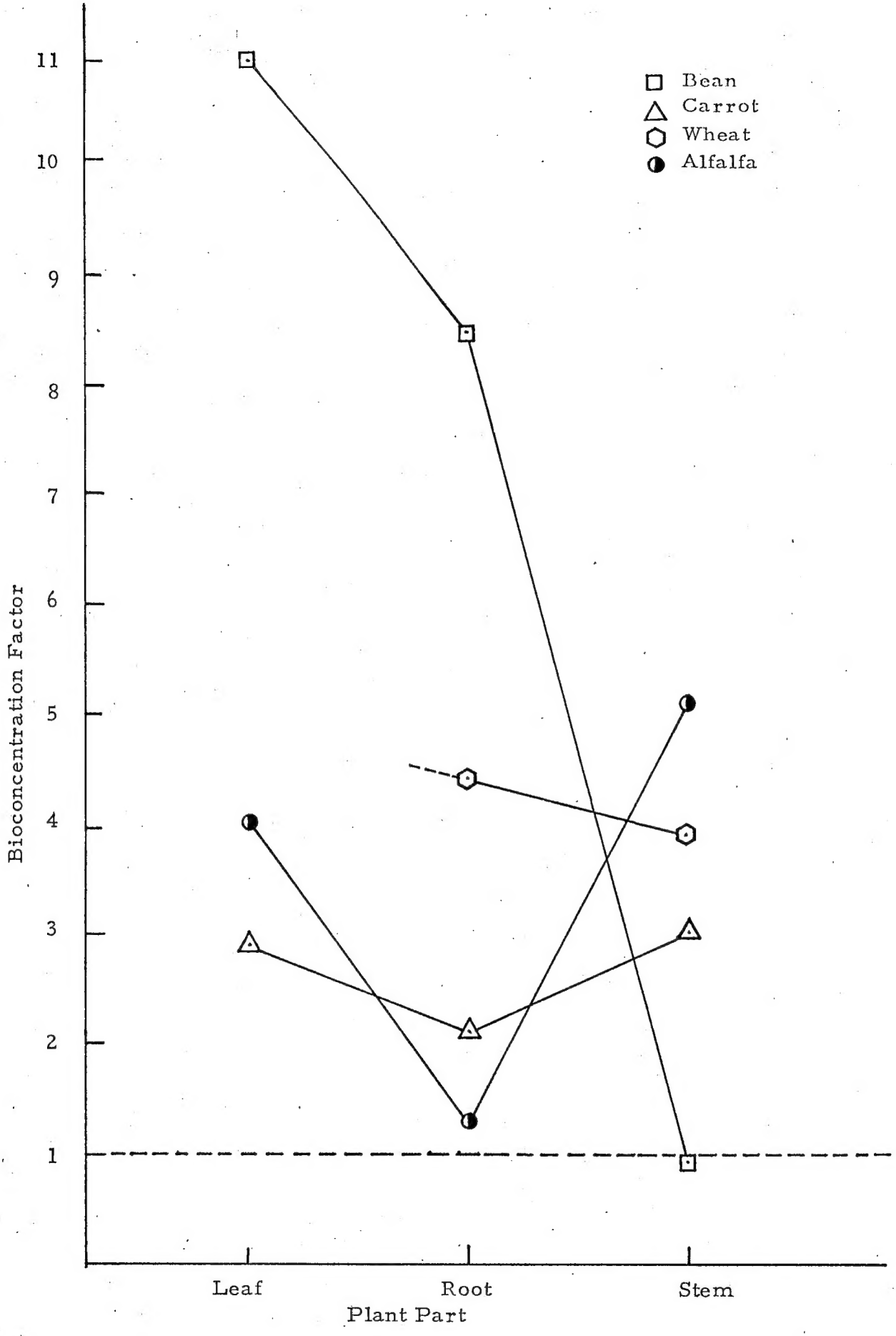


Figure 6., Bioconcentration of DIMP by Plant Parts.
Soil Culture, 65 days Exposure to 1 ppm DIMP in Irrigation Water.

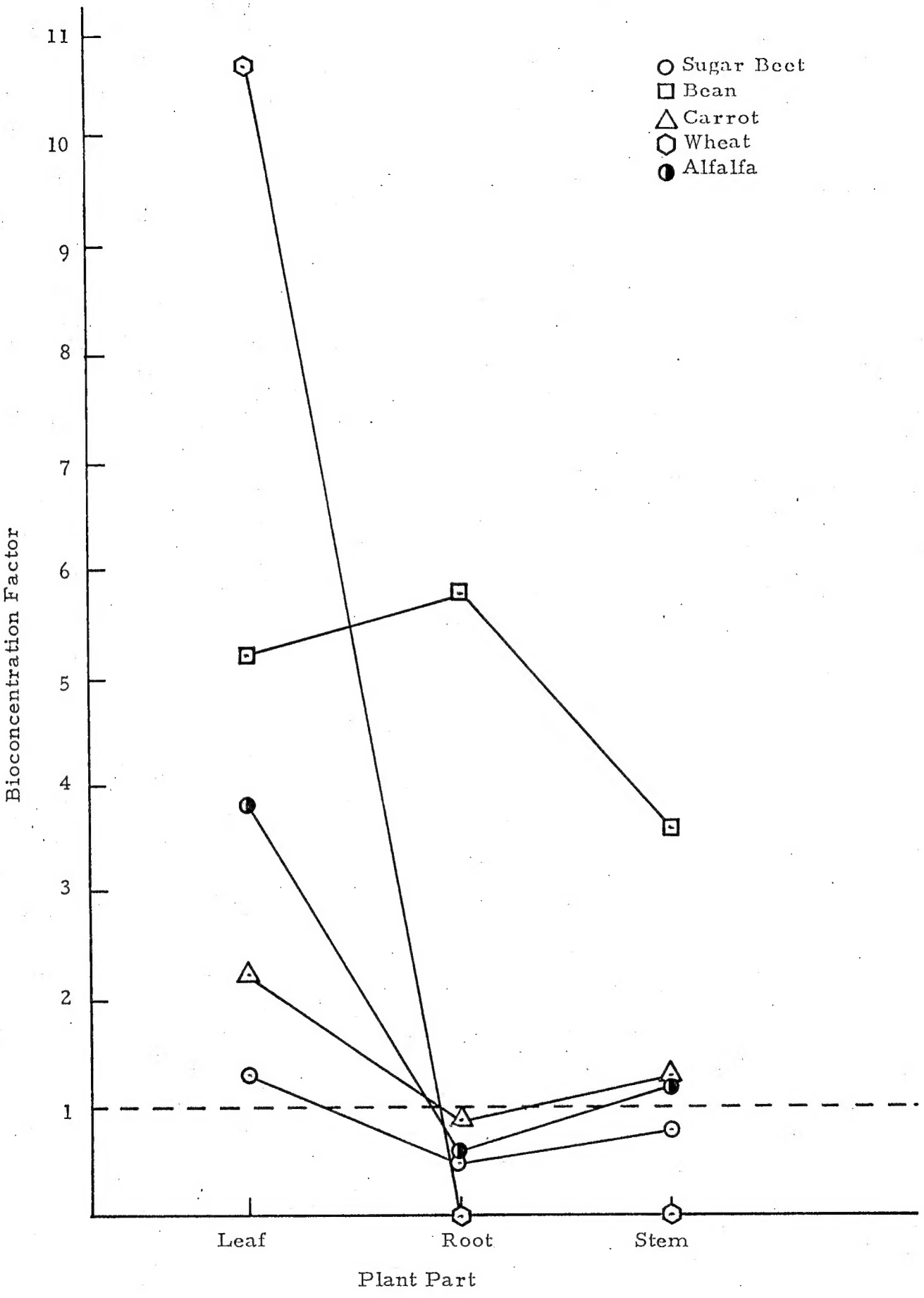


Figure 7., Bioconcentration of DIMP by Plant Parts.

Soil Culture, 65 days Exposure to 8 ppm DIMP in Irrigation Water.

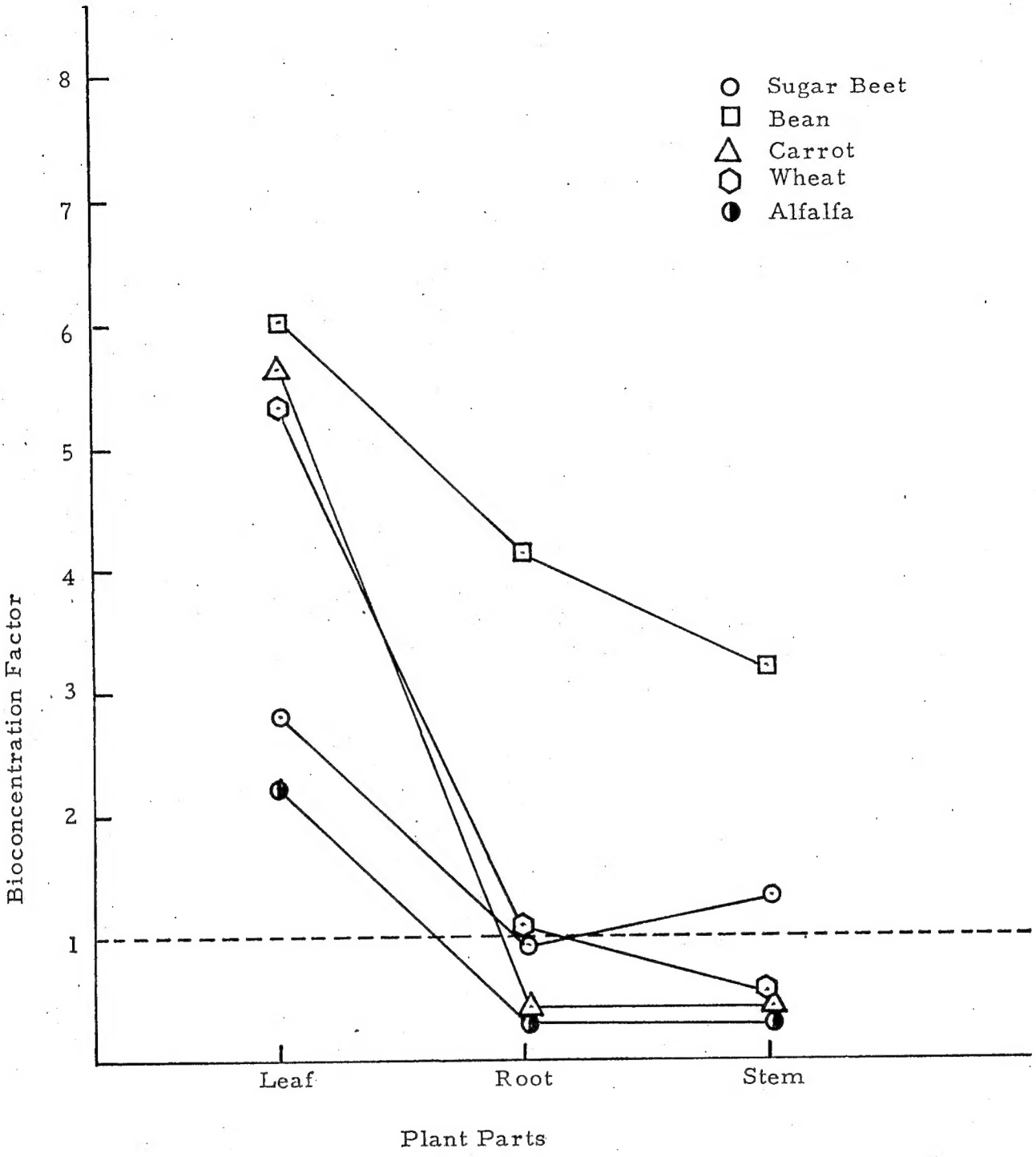


Figure 8., Bioconcentration of DIMP by Plant Parts.
Soil Culture, 65 days Exposure to 20 ppm DIMP in Irrigation Water.

The germination tests on the same five species of plants in contaminated soil have shown that neither DIMP nor DCPD in the irrigation water up to concentration levels of 1000 ppm prevent germination. The plants, however, upon reaching an age of approximately two weeks begin to show phytotoxic symptoms. These tests are continuing as are a range finding toxicity series on wheat and bean plants in soil culture. At this time it appears that the DIMP produces obvious phytotoxic symptoms at the 300 ppm level in soil irrigation and the DCPD appeared to prevent optimum growth patterns at the 700 ppm level. These effective concentration levels appear to be a function of plant age and, therefore, the plants will be kept under observation for a longer period.

PROPOSED ACTIVITY DURING SEPTEMBER, 1976

- Continue soil culture growth experiments including plant tissue analysis for contaminants.
- Continue treatment and analysis of lysimeter soil and water samples.
- Develop procedures for analysis of DCPD in soils.
- Continue germination tests on seeds in contaminated seed beds at several concentration levels of contaminants DIMP and DCPD.
- Continue toxicity range finding test on wheat and bean seedlings.
- Prepare annual report of research activities.